Type D Traumatic Carotido-cavernous Fistula due to Selective Transection of the Inferolateral Trunk(ILT)

Diagnosis and Endovascular Treatment

I.C. DUNCAN, P.A. FOURIE

Unitas Interventional Unit, Centurion; South Africa

Summary

A minority of traumatic carotido-cavernous fistulas (CCF) are of the indirect variety, and then usually supplied only by meningeal branches of the ipsilateral external carotid artery (Type C). We describe a case of a Type D CCF due to traumatic injury of the inferolateral trunk (ILT), and describe its angiographic features and endovascular management through both the external and internal carotid arteries following a failed transvenous approach.

Case Report

A 37 year-old male sustained a blunt frontal head injury in a motor vehicle accident. Shortly afterwards he developed proptosis and chemosis of the left eye with slow progressive visual deterioration thereafter. There were no cranial nerve deficits and no bruit was heard. He tolerated these symptoms for 17 months before seeking further medical attention because of increasing discomfort due to the proptosis and worsening of his vision in the affected eye.

Suspecting a post-traumatic carotico-cavernous fistula clinically, the patient was transferred to our unit for angiography and possible therapeutic embolization.

The presence of a slow-flow carotido-cavernous fistula (CCF) was confirmed at angiography. This did not appear to be due to a tear within the wall of the intracavernous internal carotid artery (ICA) itself. Instead a small pseudoaneurysm was noted filling from a small branch of the C5 portion of the ICA, which in turn drained anteriorly via an arteriovenous fistula through the cavernous sinus and superior ophthalmic vein. Cortical venous drainage was also noted involving the left sphenoparietal sinus and superficial Sylvian veins. Further collateral arterial supply to the fistula was noted from the accessory meningeal artery and the petrosal branch of the middle meningeal artery. Given the position of the false aneurysm and fistula with the additional contributions by the ipsilateral middle and accessory meningeal arteries we concluded that selective transection of the inferolateral trunk (ILT) had occurred resulting in a traumatic indirect or type D CCF.

The patient was placed under general anaesthesia and was given intravenous heparin so as to maintain the activated clotting time (ACT) at around 300 seconds. A 6F Lumax guiding catheter (Northstar Lumax, Cook, Bloomington IL, USA) was placed into the C1 segment of the ipsilateral ICA. Several attempts were made at trying to pass an Excelsior microcatheter (Target Therapeutics, Fremont CA, USA) through the opening at the ILT, all of which initially failed. A transvenous approach

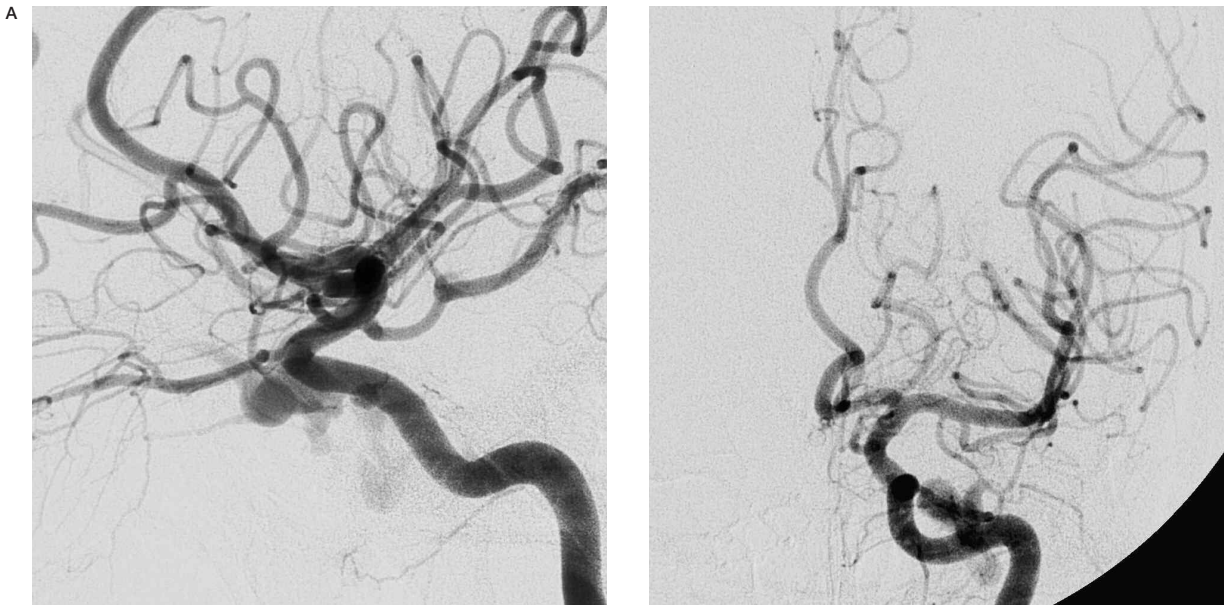

Figure 1 A) Selective left internal carotid digital subtraction arteriogram, lateral projection, showing the slow-flow fistula arising from the C5 portion of the ICA. B) Same vessel, frontal projection, showing the fistula lying lateral to the intracavernous ICA.

was considered but retrograde venography performed via the left inferior petrosal sinus showed no communication with the intracavernous compartment into which the fistula was draining. We were also unable to pass a microcatheter or microwire into the affected compartment via this route. Realising that as there was also no drainage via the contralateral inferior petrosal sinus we would probably be unable to access the affected compartment via a contralateral retrograde venous approach, we therefore decided to abandon the transvenous approach at this stage.

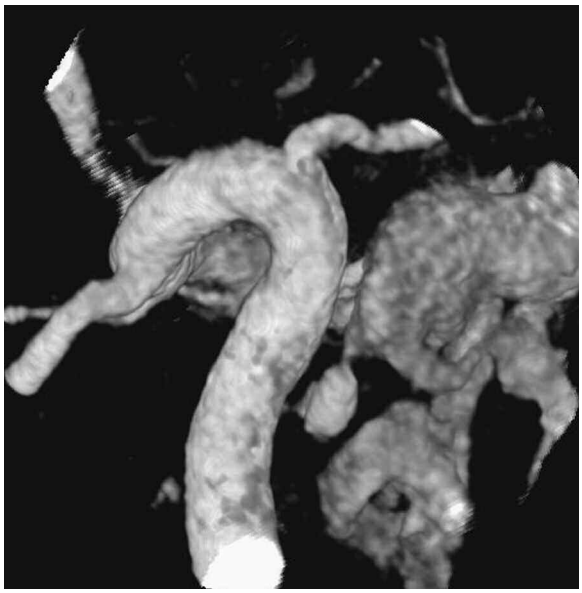

Figure 2 Three dimensional rotational angiogram, volume-rendered image, inferior projection, showing the small pseudoaneurysm inferolateral to the ICA, draining in turn anteriorly through the upper cavernous sinus.

The Excelsior microcatheter was then placed into the branch of the left accessory meningeal artery supplying the fistula. This was embolized using a cyanoacrylate/Lipiodol mixture of 1:8 in order to achieve good distal penetration of the glue into the fistula. This resulted in closure of the contributions of both of the external carotid supplying vessels as well as disconnection of the cortical venous reflux from the rest of the fistula within the cavernous sinus.

A Tracker 10 Unibody catheter was then selected and steam-shaped to form a long 90 degree curve at its tip. This was then placed through the ipsilateral ICA and successfully manipulated over a Transend 0,010 inch guidewire (Target Therapeutics, Fremont CA, USA) through the opening of the ILT into the small proximal pseudoaneurysm. This pseudoaneurysm was then occluded with one 3 mm x 4 cm and one 2 mm x 4 cm Guglielmi Detachable

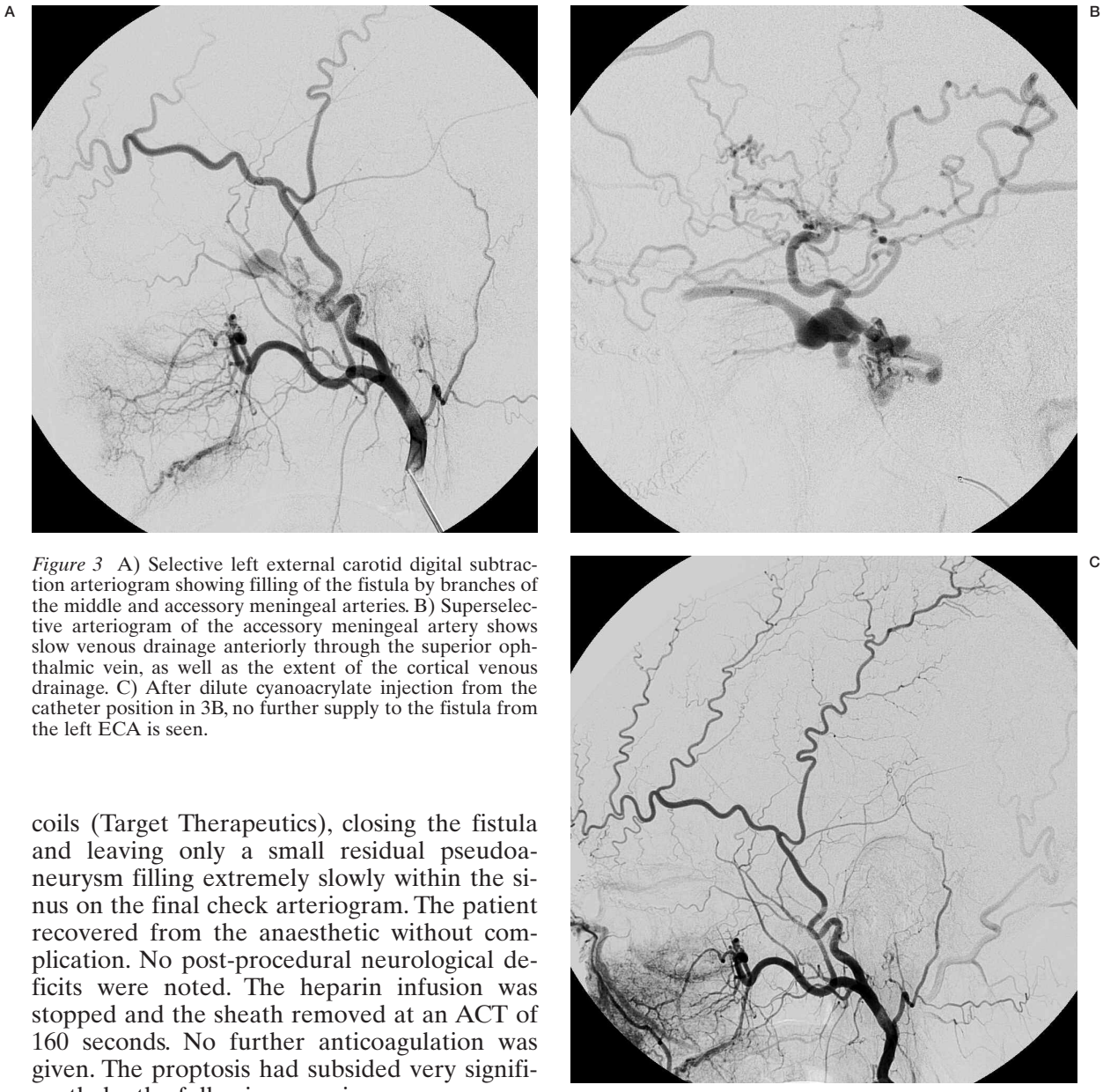

Figure 3 A) Selective left external carotid digital subtraction arteriogram showing filling of the fistula by branches of the middle and accessory meningeal arteries. B) Superselective arteriogram of the accessory meningeal artery shows slow venous drainage anteriorly through the superior ophthalmic vein, as well as the extent of the cortical venous drainage. C) After dilute cyanoacrylate injection from the catheter position in 3B, no further supply to the fistula from the left ECA is seen.

coils (Target Therapeutics), closing the fistula and leaving only a small residual pseudoaneurysm filling extremely slowly within the sinus on the final check arteriogram. The patient recovered from the anaesthetic without complication. No post-procedural neurological deficits were noted. The heparin infusion was stopped and the sheath removed at an ACT of 160 seconds. No further anticoagulation was given. The proptosis had subsided very significantly by the following morning.

The patient has since defaulted on a 6 month angiographic follow-up but remains clinically well 7 months later with no recurrent symptoms but also no further improvement in the degree of the pre-procedural visual loss.

Discussion

The inferolateral trunk (ILT), also referred to as the artery of the inferior cavernous sinus, represents the persistent remnant in adults of the embryological dorsal ophthalmic artery. It arises between the C5 and C6 embryological segments of the intracavernous internal carotid artery (ICA). The branches of the ILT have anastomoses with several other arteries including the artery of the foramen rotundum, the accessory meningeal artery, the marginal tentorial artery and the superficial and deep recurrent ophthalmic arteries [1,2]. Within the cavernous sinus the ILT is involved with blood supply to the third, fourth, fifth and sixth cranial nerves and many also contribute to the intrapetrosal part of the facial nerve. Complete regression of

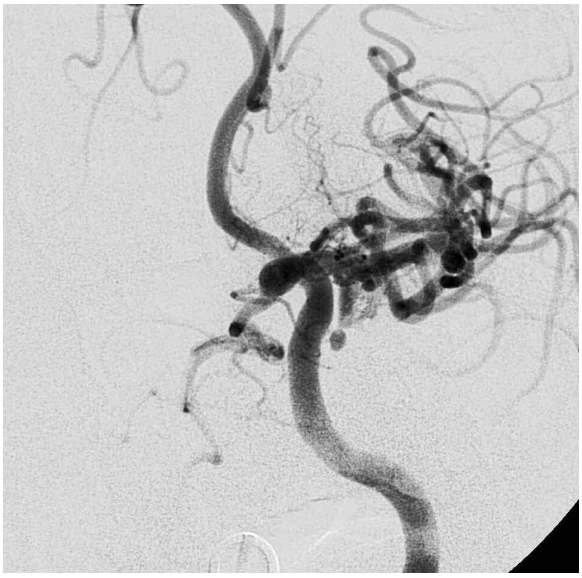
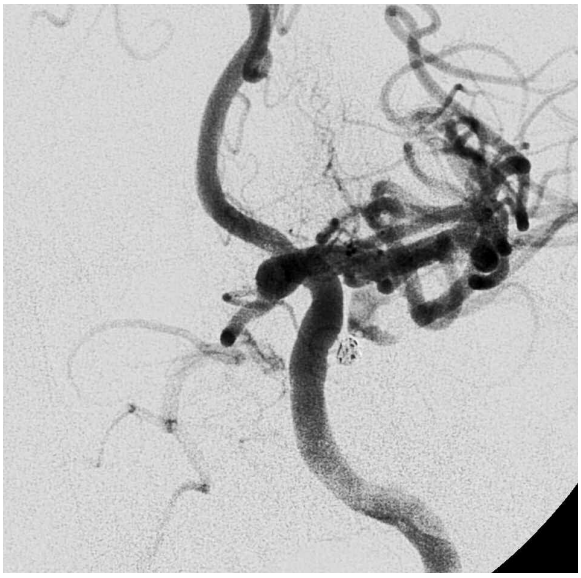

Figure 4 A) Selective left ICA digital subtraction arteriogram, submentovertical projection, after the ECA embolization showing some persistent slow filling of the fistula anterior to the small pseudoaneurysm. The cortical venous reflux is no longer seen. B) Same projection after coil placement in the proximal pseudoaneurysm. There is slow filling of a residual cavity within the cavernous sinus at this stage, but no opacification of the superior ophthalmic vein is noted later on during the same run.

the proximal part of the embryological dorsal ophthalmic artery may result in there being no patent ILT in some individuals. The ILT is absent in less than 20% of individuals [3].

Most traumatic CCF's are of the direct or Barrow Type A variety, and conversely most direct or Type A CCF's are traumatic in origin [4,5]. The Barrow Types B, C and D generally represent dural arteriovenous fistulas (DAVF) of the cavernous sinus. The fistula in the traumatic Type A CCF is generally due to a tear in the wall of the ICA although occasionally a complete transection may occur. The tear is most often found in the posterior genu or proximal horizontal segment of the intracavernous ICA, generally measuring between 2-5 mm in size.

In 1967, Parkinson described a case of traumatic CCF that required eventual surgical repair via a direct transcavernous approach after having failed initially to respond to trapping and embolization [6]. Upon opening the cavernous sinus he found two torn branches of the intracavernous segment of the ICA, thought to be the capsular artery of McConnell and the artery of the inferior cavernous sinus (or ILT). Based upon this and a similar case reported by the same author 2 years before [7], Parkinson described two types of traumatic arterial fistulae within the cavernous sinus being Type 1 where the carotid artery itself is torn, and Type 2 where a branch of the intracavernous carotid is torn.

Higashida et Al reported seven cases of indirect CCF out of a total of 213 traumatic CCF's (3%) [8]. In the report by Debrun et Al, 95 traumatic CCF's were reported out of 132 direct and indirect CCF's [5]. All were Type A with no traumatic indirect fistulas specifically described. In general, indirect traumatic CCF's are rare and when reported appear to be mainly Type C, i.e. being fed by meningeal branches of the ECA. Most direct traumatic fistulas can be successfully treated using detachable balloons via the transarterial route, usually with preservation of the parent artery [5,8]. Transarterial occlusion using balloons may not be possible in between 5 and 10% of cases [9,10], in which setting transvenous embolization may be helpful [9]. Small tears of ≤ 2 mm cannot be treated by balloon embolization but in some instances can still be treated transarterially by passing a microcatheter through the tear and occluding the cavernous sinus using microcoils [11] It is quite possible that some of these small, relatively low-flow fistulas may be due to avulsion or transaction of one of the branches of the intracavernous ICA rather than a tear of the ICA itself.

In our case we realized that the fistula was not arising simply from a tear in the ICA itself partly because of the low-flow nature of the fistula, but mainly because of the significant supply to the fistula from the external carotid (ECA), particularly via the accessory meningeal artery which is known to anastomose with the inferolateral trunk (ILT).

We realized from the onset that balloon occlusion was not feasable and that microcatheter-directed embolization was required. Our first attempt at transarterial catheterization of the fistula failed due to the fact that we could only just pass a guidewire tip through the opening of the ILT but the chosen catheter would not follow.

A transvenous approach then failed when we were unable to pass a guidewire through the inferoposterior cavernous sinus into the compartment affected by the fistula. As urgent treatment was indicated by virtue of the presence of cortical venous reflux [12], we attempted closure of the fistula via the ECA.

We felt that this would be relatively safe given that the ILT was transected and that we would thus be unlikely to reflux any significant volume of cyanoacrylate into the ICA. We chose to use a very dilute mixture of cyanoacrylate in order to penetrate the fistula adequately. We did contemplate the use of a balloon in the ICA across the opening of the ILT but felt that if we were able to control the speed and pressure of the glue injection adequately we would probably not reflux glue into the ICA. As it happened we were able to get enough glue to penetrate into the cavernous sinus to disconnect the cortical venous drainage, but not to close the fistula.

We succeeded in catheterising the opening of the ILT on the second attempt by using a non-braided 0,010 inch lumen microcatheter with its tip bent into a relatively wide diameter 90° curve. This allowed us to place two detachable coils into the proximal false aneurysm that effectively closed the fistula. We felt that the small residual false aneurysm seen at the end of the procedure would probably thrombose once the systemic heparinization was reversed. Although we have no long-term angiographic follow-up on the case, the patient remains clinically well with no recurrent symptoms and no other neurological complications.

In conclusion, in the scenario of a low-flow post-traumatic CCF filling from both the internal and external carotid arteries (Type D), the presence of a damaged intracavernous branch, particularly the ILT in the anterior cavernous sinus, should be considered. Treatment of such a lesion may be performed transarterially via the ICA, transvenously, or possibly even transarterially via the ECA.

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Ian C. Duncan FFR ad (D)SA
Unitas Interventional Unit
PO Box 14031
Lyttelton
0140 South Africa
E-mail: docdunc@iafrica.com